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DISTRIBUTION AND POPULATION CHARACTERISTICS OF MULE DEER ALONG THE EAST FRONT, NORTHCENTRAL MONTANA

BY WAYNE F. KASWORM

EAST SLOPE ROCKY MOUNTAIN FRONT MULE DEER
STUDY AND INVESTIGATION

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ABSTRACT

This study was conducted from June 1979 to September 1980 on the Rocky Mountain East Front of northcentral Montana. It was the first phase of a 2 part investigation designed to provide quantitative baseline information on mule deer seasonal distribution, movements, population status and trend, and habitat usage on a representative portion of the East Front subject to oil and gas development. Areas used by deer during average and severe winters remained relatively constant during the last 3 years. Deer displayed a high degree of fidelity to seasonal ranges. On this basis, 6 essentially independent populations were delineated by winter range origin. Movement to summer home ranges appeared rapid and direct via distinct migration corridors. Summer distribution indicated that 3 subpopulations could be delineated for each winter range. Mean summer home range size for females was larger in 1979 (7.2 km^2) than 1980 (2.7 km^2). Fall transitional ranges were identified. The pattern of transitional range use appeared to concentrate deer from 1 of the 3 subpopulations during hunting season. Age distribution of a sample of 69 deer indicated an adult population structure of 26% males and 74% females. Poor representation of the 1½-, 2½-, and 6½+-year-old age-classes was noted. These anomalies appeared related to weather, fawn production and survival, and hunter harvest. Fawn:adult ratios for 1979-1980 were not significantly different among the 5 winter ranges intensively sampled. Average fawn:adult ratios over all winter ranges were 69.3 (early winter) and 61.7 (late winter). Population estimates indicated that the population on the study area had grown by 12-15% during each of the last 3 years. Densities on winter range varied from 5 deer/km^2 to 60 deer/km^2. Total summer range density was estimated at 2.1 deer/km^2. Winter range deer density showed no clear relationship to proportions of vegetation type, slope, or aspect categories for each winter range. Mean elevation of each winter range was negatively correlated to deer density. The summer range subpopulation with the most diverse habitat, on the basis of vegetation, aspect, slope, and elevation, had the smallest mean summer home range. The similarities and independence of the 5 winter ranges provide an excellent opportunity to evaluate the impacts of oil and gas development through monitoring experimental (development) and control (no development) winter ranges.

INTRODUCTION

This study was initiated in 1979 to help evaluate potential impacts of oil and gas exploration on mule deer (*Odocoileus hemionus*) along the East Front of the Rocky Mountains. The East Front is part of the disturbed or overthrust belt that extends from Canada through Montana into Utah and Wyoming. This area is believed to have high potential for natural gas production (Mudge et al. 1978). Drilling during autumn of 1980 confirmed this potential (Montana Oil Journal 1981).

Existing information on mule deer in the area consists largely of: range use and food habits in the Sun River area (Schallenberger 1966), biological data (McCarthy, Watts, Feist, Erickson, and Bucsis 1978, unpubl. P-R Job Prog. Rep., Proj. W-130-R-8, Job I-4), and management surveys conducted by Montana Fish, Wildlife, and Parks Department (MFWPD) personnel to assess population composition and trend. Specific data on seasonal distribution, movements, and habitat usage are limited. Intensive studies have been conducted on bighorn sheep (*Ovis canadensis*) (Schallenberger 1966, Erickson 1972, Frisina 1974), elk (*Cervus elaphus*) (Picton 1960, Knight 1970, Picton and Picton 1975), grizzly bear (*Ursus arctos*) (Schallenberger and Jonkel 1978, 1979, 1980, Aune 1981), and mountain goat (Thompson 1981).

This study was conducted from June 1979 through September 1980. It was the first phase of a 2 part investigation designed to provide quantitative baseline information of seasonal distribution, movements, population status and trend, and habitat usage. Results will have implications for management of conflicts between oil and gas development and mule deer on the entire mountain front area of the overthrust belt.

STUDY AREA

The study area was located approximately 112 km northwest of Great Falls, Montana on a 64-km segment of the East Front. The 2,725 km^2 area was bounded on the north by the Blackfoot Indian Reservation and on the south by the Sun River (Fig. 1). Approximately 85% of the surface area was included in the Lewis and Clark and Flathead National Forests. The Bureau of Land Management (BLM) administered 62 km^2 (2.3%) of surface, but also controlled 95% of the mineral rights on the study area. Other lands along the foothills were divided among the State of Montana and private individuals and organizations.

Geology

The Rocky Mountain Front is characterized by north-south trending thrust faults with moderate sloping west faces and precipitous east faces. Deiss (1943) described geological features east of the Continental Divide, and Johns (1970) described features west of the divide. The mountains were created when the Lewis overthrust forced Paleozoic limestones and shales over more recent Mesozoic sediments. Many of the rocks exposed today are from the Middle and Upper Cambrian, Upper Devonian, Mississippian, Upper Jurassic, and Cretaceous periods. The retreat of Wisconsin glaciation left cirques, U-shaped valleys, and outwash that now characterize the area. Elevations range from 1,311 m along the Sun River to 2,863 m at the summit of Rocky Mountain.

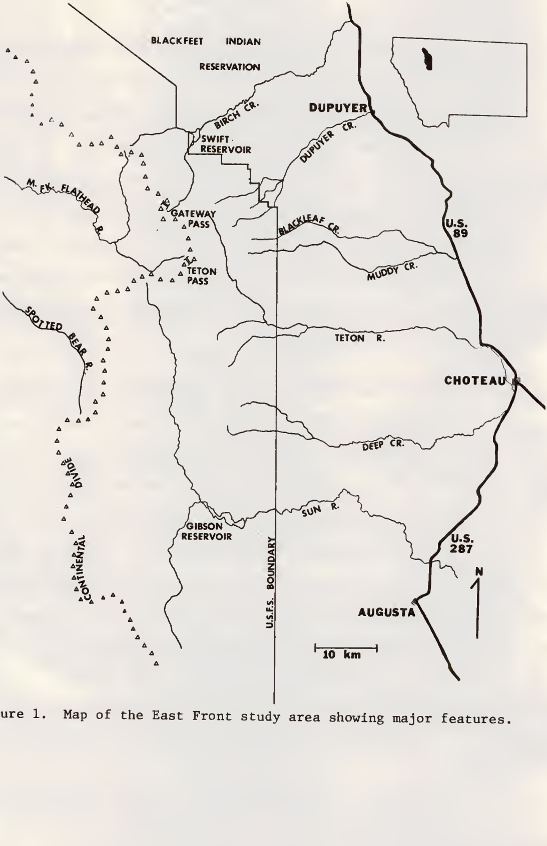

Figure 1. Map of the East Front study area showing major features.

Climate

Average annual precipitation at weather stations along the Front ranges from 35 to 48 cm (Appendix Table 13). Temperature is less variable, with an annual average of about 5°C. Southwesterly chinook winds play an important role in modifying winter weather.

Temperatures during the winter of 1978-79 were much lower than average and precipitation was greater than average. Winter temperatures on the winter range during 1979-80 were approximately average. Precipitation amounts at stations along the mountain front were greater than average in every month; however, mountain snowpack water content during the 1979-80 winter was 23% below the long term average (USDA Soil Conservation Service 1980).

Land Use

Approximately 90% of the winter range for mule deer was located on private lands used for livestock grazing during spring, summer, and fall. A small subdivision occupied a portion of a winter range along the Teton River. Most houses were occupied only during early spring through fall. The MFWPD administered two game ranges on the study area. The Ear Mountain Game Range was purchased in 1976, and the Blackleaf Game Range was purchased in 1979. Neither area had been legally grazed by livestock since those dates. The BLM had also withdrawn cattle grazing from some lands within those game ranges that were managed primarily for wildlife through cooperative agreements between the BLM and MFWPD.

The BLM and Lewis and Clark National Forest administered several livestock grazing allotments on the summer range. Permitted animal unit months (AUMs) were reduced 55% between 1955 and 1975, then increased by 18% in 1979 in response to improved range condition on some allotments (Kasworm and Irby 1979, unpubl. Ann. Rep., East Slope Rocky Mountain Front Mule Deer Study). Timber harvest on the summer range was negligible. Much of the summer range lay within the Bob Marshall and Great Bear Wilderness areas.

Vegetation

The study area was characterized by shortgrass prairie intergrading with a narrow foothill region composed of mountain grassland and limber pine (*Pinus flexilis* James) forests and savannahs. The transition from foothills to mountains was abrupt with sheer limestone reefs ranging up to 250 m in height. A more detailed description of specific cover types delineated during the study will be presented in the results section. Plant nomenclature follows Hitchcock and Cronquist (1973).

Winter Range

Grassland. Bunchgrasses dominated the grassland sites. Dominant graminoids were rough fescue (*Festuca scabrella* Torr.), bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. & Smith), and Idaho fescue

(*Festuca idahoensis* Elmer). Other common plants were creeping juniper (*Juniperus horizontalis* Moench), fringed sagewort (*Artemisia frigida* Willd.), and silky lupine (*Lupinus sericeus* Pursh).

Shrub-grassland. Major shrubs encountered in this community were shrubby cinquefoil (*Potentilla fruticosa* L.), big sagebrush (*Artemisia tridentata* Nutt.), and Arkansas rose (*Rosa arkansana* Porter). Rough fescue, Idaho fescue, bluebunch wheatgrass, timothy (*Phleum pratense* L.), arrowleaf balsamroot (*Balsamorhiza sagitta* (Pursh) Nutt.), northern bedstraw (*Galium boreale* L.), and silky lupine were the dominant herbaceous species in this community.

Conifer Forest. Limber pine was the dominant tree species over much of the winter range; however, Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco.) often accompanied it, and in some stands replaced it as the dominant tree. Understory shrubs included shrubby cinquefoil, Canadian buffalo-berry (*Shepherdia canadensis* (L.) Nutt.), creeping juniper, and kinnikinnick (*Arctostaphylos uva-ursi* (L.) Spreng.). Major herbaceous species in this community consisted of rough fescue, bluebunch wheatgrass, Idaho fescue, northern bedstraw, and silky lupine.

Summer Range

Most of the summer range was coniferous forest with small amounts of grassland and shrub-grassland. The latter two communities were similar to the previous descriptions of those types on winter range.

Douglas fir types were common across the summer range at the lower and mid-elevations. The most common understory indicator species associated with this type were pinegrass (*Calamagrostis rubescens* Buckl.), elk sedge (*Carex geyeri* Boott), shiny-leaf Spirea (*Spirea betulifolia* Pall.), and heart-leaf Arnica (*Arnica cordifolia* Hook.).

High and mid-elevation sites were dominated by subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) with small amounts of Engelmann spruce (*Picea engelmannii* Parry). Whitebark pine (*Pinus albicaulis* Engelm.) and limber pine were also common on high elevation sites, however, the observed distribution of the two species appeared related to parent material on the site. Limber pine was most common at all elevations on the Front Range where soils were calcareous due to the limestone parent material. Whitebark pine was more common at high elevations farther into the mountains along the Continental Divide where soils were less calcareous. A similar relationship has been noted in the Bridger Mountains by Pac (1976). Common understory indicator species associated with subalpine fir types were Menziesia (*Menziesia ferruginea* Smith), twinflower (*Linnaea borealis* L.), beargrass (*Xerophyllum tenax* (Pursh) Nutt.), whortleberry (*Vaccinium scoparium* Leiberg), and virgins-bower (*Clematis pseudoalpina* (Kuntze) Nels.).

Lodgepole pine (*Pinus contorta* Dougl.) often occurred in dense, almost pure stands. Fires burned over many portions of the study area between 1915 and 1940. These stands may be fire induced seral communities or climax stands on sites unfavorable for the establishment of other conifers.

METHODS

Seasonal Distribution

Panel traps (Lightfoot and Maw 1963) were used to capture and attach transmitter collars on 2 deer in March of 1978 and 18 deer in February and March of 1979 on 4 different winter ranges. They also were used to capture 7 deer at Castle Reef during March and April of 1980. Two of those animals were radio-collared, and the remainder were neckbanded. In February of 1980, a drive-net technique (Beasom et al. 1980) was utilized to capture 71 mule deer at 4 sites. Four deer were equipped with radio-collars, and the remainder were neckbanded. Two fawns were captured by hand during June and marked with orange ear tags.

Helicopter surveys were made during March and April of 1980 to establish winter distribution and obtain estimates of population size. Surveys were flown for complete coverage of the winter range. Radio relocations and observations of marked animals from the air and ground also aided in delineation of winter range units. Aircraft used in the relocation of radio-collared animals included a Cessna 180 equipped with twin whip antennas and a Piper Super Cub with a 3-element Yagi antenna attached to the strut. Animals were relocated at approximately 2-week intervals over most of the year. Additional relocations were made during fall and spring, to identify movement corridors.

Seasonal home range size was determined with the aid of TELDAY, a computer program developed by Terry N. Lonner (MFWPD). Statistical methods used to compare summer range sizes between years and among areas follow Snedecor and Cochran (1967).

Population Dynamics

Marked deer in the population provided a basis for using Lincoln index census techniques (Overton and Davis 1969). The helicopter surveys produced two population estimates during 1980 for comparison.

The age and sex composition of the sample of deer captured during the drive-net operation was examined. Age was determined by tooth replacement and wear (Robinette et al. 1957).

Ground counts of fawns and adults were made at each winter range. Comparisons of fawn:adult ratios were made among winter ranges and time periods.

Habitat Characterization

Cover-type maps and quantitative vegetation measurements were made on winter (1979-1980) concentration sites during the early summer of 1980. Cover-types for winter range generally followed habitat types developed by Pfister et al. (1977) and Mueggler and Stewart (1980), with some modifications due to the influence of domestic livestock grazing on the vegetation. Transects were used to sample representative portions of each cover-type. Along each transect, points and plots were established at random intervals. Canopy coverage of the ground stratum (all grasses and forbs, and shrubs less than 30 cm in height) was estimated by coverage class within 2 by 5 decimeter plots. Canopy coverage estimates followed Daubenmire (1959). Canopy coverage classes were: class 1 = 0-1%; class 2 = 1-5%; class 3 = 5-25%; class 4 = 25-50%; class 5 = 50-75%; class 6 = 75-95%; and class 7 = 95-100%. A point-centered-quarter technique (Cottam and Curtis 1956) was used to obtain density and cover estimates of the mid-stratum (woody plants greater than 30 cm in height, but less than 180 cm) and upper stratum (woody plants greater than 180 cm in height). Plant species encountered were collected and verified by Dr. J. H. Rumely, Montana State University Herbarium.

Habitat types used to describe and analyze summer range followed Pfister et al. (1977) and Mueggler and Stewart (1980). Ocular estimates of herbaceous, shrub, and tree canopy coverage were made at several representative sites for each type delineated.

Cover-type and habitat type maps were prepared for primary winter range and the summer home ranges of radio-collared deer. Density classes for the limber pine-rough fescue association were based on visual groupings noted from ground work and aerial photographs. Density categories (high, medium, and low) were verified using information from point-centered-quarter transects. Proportions of each type, as well as aspect, slope, and elevation were estimated from topographic maps by random sampling (Marcum and Loftsgaarden 1980). Aspect was categorized by 8 compass points and reduced to scalar north-south and east-west components as described by Mimmack et al. (1980). Slope categories were: level = 0-1°; gentle = 1-7°; moderate = 7-16°; and steep = 16° and greater. Elevation was rounded to the nearest 30-m increment. Principal-component analysis was used to compare winter ranges on the basis of these variables (Nie et al. 1975).

RESULTS

Seasonal Distribution

Total and primary winter ranges for each winter range unit were delineated during the winter of 1979-1980 (Fig. 2). Limited information was obtained on the Long Ridge herd segment during this study. Sizes of total and primary winter range for each area are presented in Table 1. Primary winter range sizes varied from 10 to 24 km^2 in 1980. Total winter range sizes varied from 17 to 73 km^2.

Table 1. Area (km^2) of 6 total and primary winter ranges for mule deer on the East Front during 1979-1980.

Location	Total Winter Range km^2	Primary Winter Range km^2
Scoffin Butte	16.8	10.2
Dupuyer Creek	31.7	13.4
Blackleaf-Teton	73.4	20.9
Ear Mountain	44.0	16.6
Long Ridge	37.6	23.9
Castle Reef	38.9	18.1
Total	242.4	103.1

Much of the area designated as secondary winter range was heavily used during spring. In April and May, deer generally ranged farther from tree cover than during winter. Deer were frequently observed foraging on early vegetative growth in irrigated meadows and on wet sites at this time.

Migration to summer range began in late May and early June of both 1979 and 1980. All radio-collared animals were on summer range

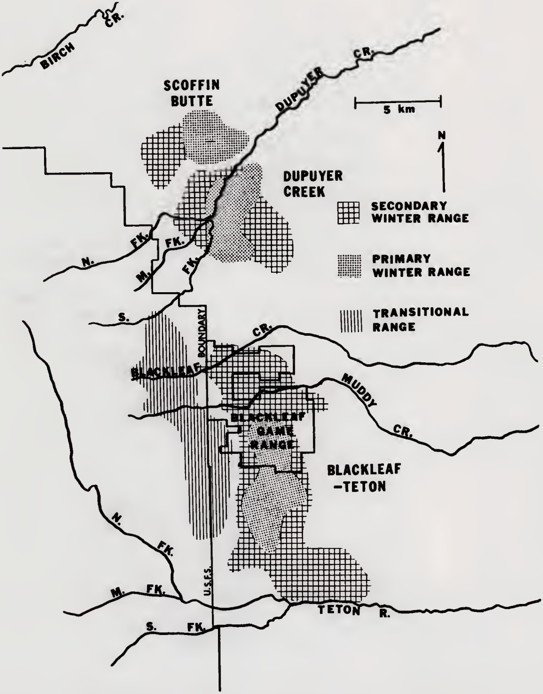

Figure 2. Map of the East Front Study area showing total and primary winter ranges, and transitional ranges as observed during 1979-1980.

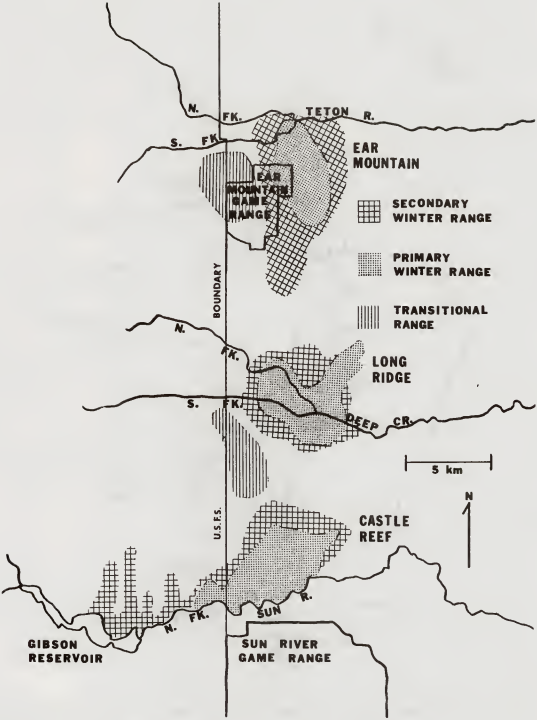

Figure 2. Continued.

by mid-June. The timing of the spring movement suggested that fawns probably were born on the females' summer ranges. Radio relocations during migration aided in defining some movement corridors (Table 2).

Table 2. Known spring or fall migration routes of mule deer using 5 winter ranges on the East Front during 1979-1980.

Winter Range	Migration Routes
Scoffin Butte	South and North Forks of Birch Creek.
Dupuyer Creek	South, Middle, and North Forks of Dupuyer Creek.[a]
Blackleaf-Teton	Blackleaf Creek, Muddy Creek, North Fork of the Teton River, Teton Pass, and Gateway Pass.
Ear Mountain	South and Middle Forks of the Teton River.
Castle Reef	South Fork of Deep Creek and the Sun River.

[a] G. Olson, pers. comm.

A high degree of fidelity to summer home ranges was noted for females. Two animals radio-collared in 1978 migrated to the same summer range for 3 successive years. Only 1 of 12 females changed summer range during this study. One instance of a female with a split summer range was noted. A female collared in 1979 on the Ear Mountain winter range, moved 8 km from the winter range to summer range in late May. In late August, she returned to her winter home range for approximately a month, after which she moved back to the previously used summer home range. The same movement pattern was followed in 1980.

Summer distribution of radio-collared deer associated with specific winter ranges are shown in Figure 3. Telemetry data indicated that mule deer using each winter range could be divided into 3 segments based on summer range relocations. The first consisted of deer that were yearlong residents on the winter range or migrated short distances into the foothills. This resident segment (RES) included about 15% of the radio-collared animals. The second segment included deer that migrated to summer ranges located between the Front Range and the Continental Divide. Radio-collared deer in the east of the divide segment (EODS) travelled 8 km to 34 km. They comprised about 60% of all radio-collared animals, indicating that this group probably included a majority of deer using East Front winter ranges. The last segment migrated across the Continental Divide to the west side in the Middle Fork of the Flathead River. Those movements ranged from 21 km to 50 km. This west of the divide segment (WODS) constituted approximately 25% of the radio-collared deer.

The mean summer home range size of females for which 2 years of relocations were available (Table 3) decreased significantly (t-test, $p = 0.1$) from 1979 (mean = 7.2 km^2) to 1980 (mean = 2.7 km^2). The mean size of summer home ranges for all females in the EODS decreased significantly from 6.0 km^2 in 1979 to 1.6 km^2 in 1980 (ANOVA, $p = .02$). The WODS showed a nonsignificant decrease from 7.5 km^2 in 1979 to 3.1 km^2 in 1980 (ANOVA, $p = .09$). Home ranges of radio-collared deer in the

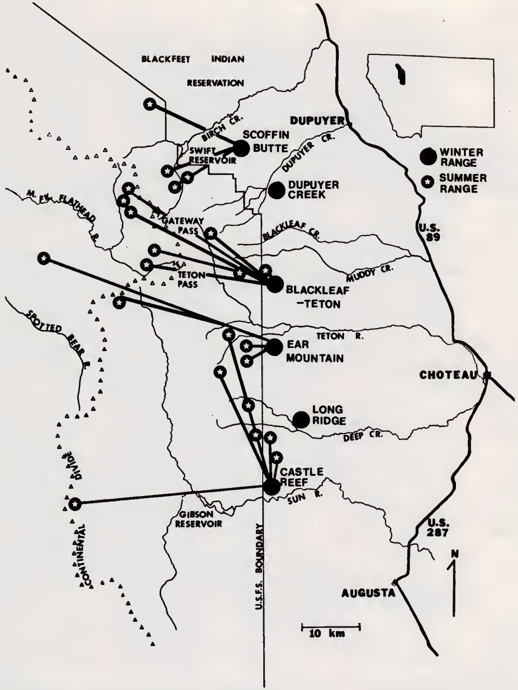

Figure 3. Locations of summer home ranges and winter range origin for radio-collared mule deer on the East Front during 1979-1980.

Table 3. Summer and winter polygon home range sizes (km^2), number of relocations (N), and seasonal home range means (km^2) for mule deer on the East Front during 1979-1980.

Animal	Sex	Summer Range segment	Summer 1979 Size	Summer 1979 N	Winter 1979-1980 Size	Winter 1979-1980 N	Summer 1980 Size	Summer 1980 N
Scoffin Butte								
1001	F	EODS	13.4	17	6.1	9	0.3	7
1002	F	EODS	7.0	13	6.3	8	0.1	6
1003	F	EODS	3.6	14				
1004	F	EODS	2.1	15	3.5	8	1.5	6
Blackleaf-Teton								
3001	F	WODS	5.5	10	7.4	7	0.3	6
3002	F	WODS	13.5	9	2.6	9	7.7	6
3003	F	WODS	9.2	8	1.7	8	5.5	6
3004	F	WODS	1.7	7	3.5	7	1.4	6
3005	F	EODS	4.0	14	1.5	4	1.0	6
3007	F	RES	2.9	13	2.7	8		
3008	F	WODS			3.0	6	0.7	6
3009	F	EODS			3.6	5	1.2	5
Ear Mountain								
4002	F	EODS	12.1	12	4.5	7	8.4	7
4004	F	EODS	2.8	10	8.0	10	0.3	6
4005	F	EODS			3.4	5	2.7	4
4006	M	WODS			3.6	6	0.5	3
Castle Reef								
6001	F	EODS	3.0	7	0.8	5	0.5[b]	6
6002	F	RES	8.4	15	6.5	5	2.7	6
6003	F	EODS			13.3	6	0.3	6
6004	F	RES			2.7	5	10.4	6
6005	M	EODS					5.8	5
			$\overline{X}$ = 6.4		$\overline{X}$ = 3.9		$\overline{X}$ = 2.7	

[a] EODS = East of Divide
WODS = West of Divide
RES = Resident

[b] Animal 6001 changed summer range between 1979 and 1980.

WODS were smaller than those in the EODS in both summers. The RES showed an increase in mean size from 5.6 km^2 in 1979 to 7.5 km^2 in 1980, but this difference was not significant (ANOVA, $p = .57$). Comparisons of summer home range sizes among segments within years showed no significant differences.

Deer of the WODS were the first to migrate in the fall. Movement eastward across the divide appeared to be keyed to late fall snowstorms. Those animals moved to transitional ranges located in the foothills above the winter range (Fig. 2). In 1979, transitional range was used from late October to late December. Transitional range was also used by the EODS, but for a shorter time. As snow accumulated, all animals moved on to the winter range. Fidelity to winter range was high among radio-collared animals with all animals returning to the winter range where they were instrumented. Only one instance of a change in winter range has been noted: a 2½-year-old female, neckbanded on the Sun River Game Range in 1978 as a fawn, was sighted on the Castle Reef winter range in February of 1979 (McCarthy, Watts, Feist, Olson, and Bucsis 1979, unpubl. P-R Job Prog. Rep., Proj. W-130-R-10, Job. I-4) and again in January of 1980.

Population Dynamics

The sex and age of animals captured during drive-netting in February, 1980 (Table 4) provided an estimate of population structure.

Table 4. Numbers and percentages of sex and age classes for mule deer captured during drive-netting on the East Front in February, 1980.

Sex	Fawn	1½	2½	3½	4½	5½	6½	7½	8½	9½	10+	Total
Male	15	1	2	6	2		1					27
(%)	(22)	(1)	(3)	(9)	(3)		(1)					(39)
Female	8	4	2	6	10	8	2		1		1	42
(%)	(12)	(6)	(3)	(9)	(14)	(12)	(3)		(1)		(1)	(61)
Total	23	5	4	12	12	8	3		1		1	
(%)	(32)	(7)	(6)	(17)	(17)	(12)	(4)		(1)		(1)	N = 69

Males comprised 26% of the 1½-year-old and older animals, but nearly 65% of the fawns. Among adults, females outnumbered males by nearly 3 to 1. Age distribution of the sample indicated relatively low survival in the 1½- and 2½-year-old age-classes and few animals over 6½ years old. The proportion of fawns captured in the drive-net sample was less than that obtained from ground counts, but the difference was not statistically significant (Chi-square, $p = .14$).

Ground counts of fawns and adults made at each of the 5 winter ranges are summed by month in Table 5. Ratios showed a fairly consistent decline from February through April. A Chi-square test of independence showed no significant differences in fawn:adult ratios among the 5 winter ranges for either the early winter (January-February) or late winter (March-April) periods ($p > .50$). Fawn:adult ratios for early and late winter of 1980 were higher than the long term average (Table 6) for the corresponding MFWPD wildlife management units

Table 5. Percentages, numbers, and ratios of adult and fawn mule deer from 5 winter ranges on the East Front from January through April, 1980.

	Location	% Adult (Numbers)	% Fawns (Numbers)	Fawns/100 Adults
January	Scoffin Butte	59.7 (43)	40.3 (29)	67.4
	Dupuyer Creek	63.9 (124)	36.7 (72)	58.1
	Blackleaf-Teton	56.9 (27)	43.1 (21)	75.8
	Ear Mountain	62.9 (56)	37.1 (33)	58.9
	Castle Reef	59.8 (79)	40.2 (53)	67.1
February	Scoffin Butte	59.0 (363)	41.0 (252)	69.4
	Dupuyer Creek	58.8 (223)	41.2 (156)	70.0
	Blackleaf-Teton	57.1 (105)	42.9 (79)	75.2
	Ear Mountain	58.5 (48)	41.5 (34)	70.8
	Castle Reef	58.5 (166)	41.5 (118)	71.1
March	Scoffin Butte	62.5 (30)	37.5 (18)	60.0
	Dupuyer Creek	59.8 (116)	40.2 (78)	67.2
	Blackleaf-Teton	62.0 (88)	38.0 (54)	61.4
	Ear Mountain	60.8 (96)	39.2 (62)	64.6
	Castle Reef	62.0 (57)	38.0 (35)	61.4
April	Scoffin Butte			
	Dupuyer Creek	60.5 (49)	39.5 (32)	65.3
	Blackleaf-Teton	64.0 (121)	36.0 (68)	56.2
	Ear Mountain	65.9 (29)	34.1 (15)	51.7
	Castle Reef	62.5 (35)	37.5 (21)	60.0

Table 6. Fawns:100 adults ratios for 1979-1980, long term means, and standard deviations for mule deer on the East Front in 2 MFWPD management units, 1961-1979.

MFWPD Management Unit	Time	1979-1980	$\overline{X}$	N	Standard Deviation
441	Winter	70.8	51.3	18	13.6
	Spring	61.3	45.8	10	9.6
442	Winter	68.8	52.8	17	12.7
	Spring	61.9	46.5	12	11.9

(Kasworm, Ihsle, and Irby 1980, unpubl., Ann. Rep. East Slope Rocky Mountain Front Mule Deer Project).

Some mortality due to predation, including suspected coyote (*Canis latrans*) and golden eagle (*Aquila chrysaetos*) kills, was observed. Four instances of predation involving golden eagles occurred within a 5 km^2 area on the Castle Reef winter range in a 24-day period. All kills involved 7-8-month-old deer fawns (weighing 34-38 kg) in good physical condition. Carcasses were located by the presence of feeding eagles and scavengers. A lack of any other tracks in the fresh snow and indications of a struggle implicated eagles as the predator. On one occasion, an adult golden eagle was found feeding on a recently killed fawn that had several puncture wounds at the base of the neck and considerable subcutaneous hemorrhaging. On another occasion, 4 golden eagles (2 adults and 2 immatures) were observed feeding on a fawn carcass. The timing and proximity of the kills suggested that a single family group may have been responsible for all of the observed predation by eagles.

Table 7 presents basic data from helicopter surveys used to develop Lincoln index estimates of mule deer numbers on the study area. The proportions of marked animals seen on each flight were quite similar at 61% and 65%, respectively. Weather conditions were generally similar, though snow cover was less during the second survey. Population estimates over the area covered by both surveys showed a

Table 7. Totals, proportions of marked animals, and Lincoln index estimates for mule deer from 6 winter ranges on the East Front during March and April of 1980.

	March			April		
	Actual	Marked Animals		Actual	Marked Animals	
Winter Range	Count	Observed	Present	Count	Observed	Present
Castle Reef	896	2	8	1.047	7	12
Ear Mountain	376	18	24	214	13	24
Blackleaf-Teton	250	14	33	269	24	33
Dupuyer Creek	699	20	24	603	17	24
Scoffin Butte	524	4	5	588	3	5
Subtotal	2,745	58	94	2,721	64	98
Long Ridge	743					
Total counted	3,488					
Proportion of marked animals seen		0.617			0.653	
Subtotal Lincoln Index (excluding Long Ridge)		4,449			4,167	
Total Lincoln Index		5,653				

decrease of 6.3% between March 21 and April 13. A similar decline over the entire study area would result in an estimated population in mid-April of 5,295 animals.

Estimated population size and density of mule deer on each of the 6 winter range units during the winter of 1979-1980 are presented in Table 8. Castle Reef and Scoffin Butte had the highest densities (36-60/km^2). Long Ridge and Dupuyer Creek were moderate density winter ranges (28-35/km^2) while Ear Mountain and Blackleaf-Teton were considered low density winter ranges (5-11/km^2).

Table 8. Estimated total numbers and density (N/km^2) of mule deer for 5 winter ranges on the East Front during 1979-1980.

Location	Numbers	Numbers/km^2
Scoffin Butte	800-1,000	47.7-59.6
Dupuyer Creek	900-1,100	28.4-34.7
Blackleaf-Teton	400-500	5.5-6.8
Ear Mountain	400-500	9.1-11.4
Long Ridge	1,100-1,300	29.2-34.6
Castle Reef	1,400-1,700	36.0-43.8
Total	5,000-6,100	20.6-25.2

Total summer range area was calculated, using all radio relocations, to comprise approximately 2,725 km^2. Of this total area, 15% was in the RES, 62% was in the EODS, and 23% was in the WODS. Application of the total population estimates of March 1980 to that area resulted in an estimated density of 2.1 deer per km^2 for the total range of the East Front population.

Characteristics of Winter Range Used by Deer

Major vegetation types of the winter range were delineated and quantitatively sampled, while minor types were simply described. Measurements and descriptions were summarized by type (Appendix Tables 14, 15, 16, 17). The limber pine-rough fescue association was subdivided into 3 density classes: low (10-200 trees per hectare); medium (201-700 trees per hectare); and high (700 and greater trees per hectare). These categories were easily distinguished on aerial photographs.

The amount and proportion of each vegetation type on each primary winter range are listed in Table 9. Twenty cover-types were recognized, but 12 accounted for over 98% of the vegetation cover on the winter range area. Proportions of types varied markedly among winter ranges. Types exhibiting coefficients of variation (C.V.) among winter ranges of less than 100% were irrigated meadows, rough fescue-bluebunch wheatgrass, shrubby cinquefoil-rough fescue, medium density limber pine-rough fescue, aspen, and riparian shrub.

Vegetation was also classified by growth-form categories (Fig. 4). Growth-forms showing C.V.'s among winter ranges of less than 100% included grassland, shrub grassland, forest grassland, and riparian shrub. Proportions of the area covered by different densities of trees

Table 9. Percentages and areas (km^2) of vegetation cover types for 5 primary winter ranges for mule deer on the East Front during 1979-1980. Variations in proportions of cover-types among winter ranges are expressed as coefficients of variation (C.V.)[a].

	Scoffin Butte		Dupuyer Creek		Blackleaf-Teton		Ear Mountain		Castle Reef		Total		Mean	C.V.
Cover Type[b]	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	%
Water					0.5	0.10	0.5	0.08	1.0	0.18	0.5	0.36	0.4	105
Scree									1.0	0.18	0.2	0.18	0.2	224
Irrigated meadow	0.5	0.05	3.5	0.58	4.0	0.84	3.5	0.58			2.4	1.94	2.3	82
Fesc/Agsp	43.0	4.36	31.0	4.14	36.5	7.64	55.5	9.20	26.0	4.71	38.0	30.05	38.4	30
Artr/Fesc							1.5	0.25	3.0	0.54	1.0	0.79	0.9	149
Pofr/Fesc	11.5	1.17	19.0	2.54	14.0	2.93	19.0	3.15	6.5	1.18	13.9	10.97	14.0	38
Pofr/Phpr	27.0	2.74	12.0	1.60	6.5	1.36					7.2	5.70	9.1	123
Pifl/Fesc 1	Tr[c]	Tr	.5	.07	1.0	0.21	1.5	0.25	44.0	7.98	10.7	8.51	9.4	205
Pifl/Fesc 2	9.5	.96	19.0	2.54	16.5	3.45	14.0	2.32	3.5	0.63	12.5	9.90	12.5	49
Pifl/Fesc 3	2.5	.25									0.3	0.25	0.5	224
Pifl/Junip					7.5	1.57	0.5	0.08	4.0	0.73	3.0	2.38	2.4	138
Pifl/Aspen					0.5	0.10					0.1	0.10	0.1	224
Psme/Spbe					0.5	0.10	Tr	Tr	Tr	Tr	0.1	0.10	0.1	148
Aspen	1.5	.15	2.0	0.27	3.5	0.73	0.5	0.08	3.0	0.54	2.2	1.77	2.1	68
Riparian shrub	4.0	.41	5.5	0.73	4.0	0.84	3.0	0.50	8.0	1.45	5.0	3.93	4.9	40
Riparian tree			7.5	1.00							1.3	1.00	1.5	224
Swamp					4.5	0.94	0.5	0.08			1.3	1.02	1.0	197
Pifl/Beoc					0.5	0.10					0.1	.10	0.1	224
Pico					Tr	Tr					Tr	Tr	Tr	224
Snowdrift shrub	0.5	0.05	Tr	Tr							0.1	.05	0.1	181
Total		10.14		13.36		20.91		16.57		18.12		79.10		

[a] Coefficient of variation = (SD) 100/mean.
[b] See Appendix Table 18 for key to 4-letter plant species abbreviations.
[c] Tr = trace.

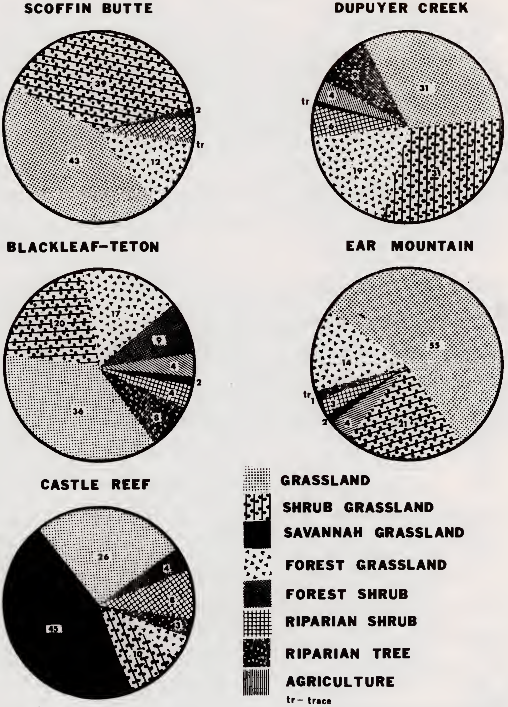

Figure 4. Percentages of vegetation growth-forms found on 5 winter ranges for mule deer on the East Front during 1979-1980.

were computed (Fig. 5). Density classes follow those described earlier for the limber pine-rough fescue association. The proportion of the winter range not covered by trees showed the least variation among winter ranges, while the low density category showed the most variations.

Topographic variation was also compared among winter ranges. Variables examined were aspect, slope, and elevation. The proportions of the area that were classified in the 8 aspect categories and the average aspect are shown in Figure 6. Ear Mountain, Blackleaf-Teton, and Scoffin Butte had an easterly average aspect. Castle Reef had a southeasterly average aspect and Dupuyer Creek had a northeasterly average aspect. Although mean slope was similar, the proportions of the area in each of the 4 slope categories varied among winter ranges (Fig. 7). Mean elevation for each winter range was: Scoffin Butte = 1,430 m (4,690 ft); Dupuyer Creek = 1,472 m (4,831 ft); Blackleaf-Teton = 1,524 m (5,000 ft); Ear Mountain = 1,551 m (5,088 ft); and Castle Reef = 1,441 m (4,727 ft).

Proportions of vegetation cover-types, aspect, slope, and elevation categories for each winter range were compared through principal-components analysis. No single variable could account for more than 8.3% of the variation among winter ranges.

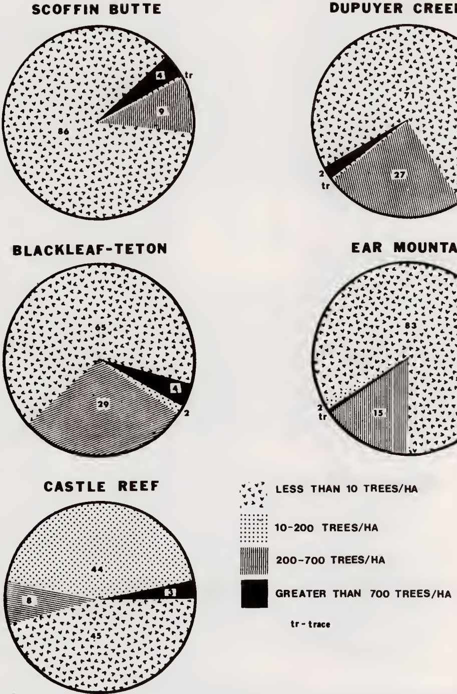

Figure 5. Percentages of 4 categories of tree density found on 5 winter ranges for mule deer on the East Front during 1979-1980.

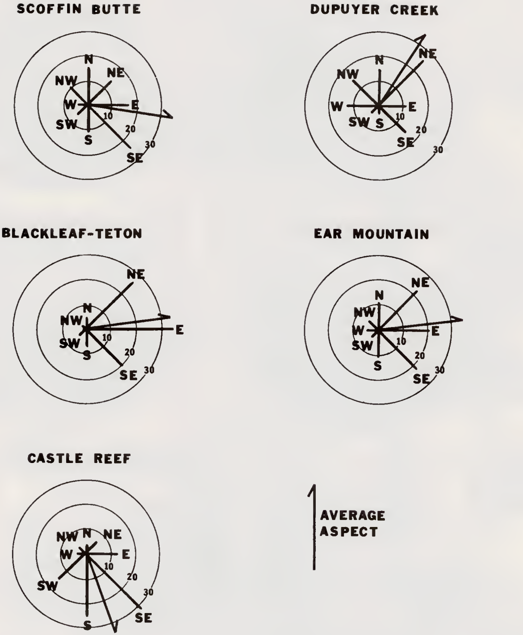

Figure 6. Percentages and average aspect found on 5 winter ranges for mule deer on the East Front during 1979-1980.

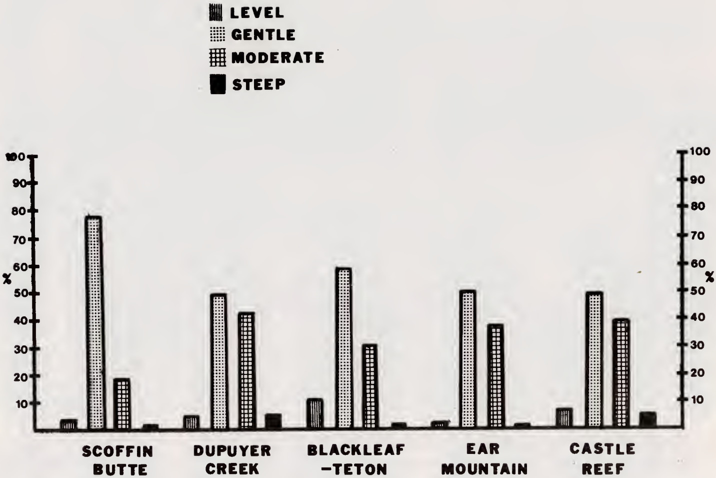

Figure 7. Percentages of 4 slope categories found on 5 winter ranges for mule deer on the East Front during 1979-1980.

Characteristics of Summer Range Used by Deer

Summer range descriptions were based on averages of habitat type, aspect, slope, and elevation proportions for home ranges of radio-collared females. Variation in the types and proportions of these variables among the summer range segments was so great that the 3 summer range segments were analyzed separately. Averages for deer in the RES included measurements from the home ranges of 2 deer. Averages for deer in the EODS were based on values from home ranges of 7 deer, and the averages for the WODS were based on 4 home ranges.

Proportions of each vegetation type within each summer range segment are shown in Table 10. The variability among the segments is illustrated by a comparison of differences in the occurrence of types between the RES and WODS. Only one type, scree, was common in both segments. The 3 types that showed C.V.s below 100% in the RES were shrubby cinquefoil-rough fescue, limber pine-rough fescue, and Douglas fir-Spirea. Scree, limber pine-juniper, subalpine fir-beargrass, and subalpine fir-Clematis showed the least variation in the EODS. Types that showed the least variation in the WODS were scree, subalpine fir-Menziesia, and subalpine fir-beargrass. Vegetatively, the RES appeared more similar to the EODS than to the WODS.

Topographic variation was also compared among summer range segments. Proportions and means for the 8 aspect categories in each segment are shown in Figure 8. The EODS and the WODS were the most

Table 10. Mean percentages of vegetation types found on 3 summer home range segments for mule deer on the East Front during 1979. Variation within segments is expressed as a coefficient of variation (C.V.)[a].

	RES		EODS		WODS	
Vegetation Type[b]	$\bar{X}$ (%)	C.V.	$\bar{X}$ (%)	C.V.	$\bar{X}$ (%)	C.V.
Stream Gravel			3.4	339		
Scree	1.0	141	9.1	83	10.5	72
Fesc/Agsp	12.0	141				
Forb Meadow					0.5	200
Pofr/Fesc	19.0	82	5.7	181		
Pofr/Feid					3.0	200
Pifl/Feid (Fesc)	23.0	80	3.4	115		
Pifl/Junip	21.0	115	20.9	75		
Pifl/Scree			6.9	121		
Psme/Spbe	13.0	54	8.0	118		
Psme/Arco			.3	265		
Psme/Junip			1.1	171		
Aspen	3.0	141	.9	184		
Riparian Shrub	1.0	141				
Pien/Smst	1.0	141	4.7	125		
Abla/Libo			1.1	138		
Abla/Mefe			6.0	171	30.5	72
Abla/Xete			16.3	67	47.0	14
Abla/Xete (Burn)					0.8	200
Abla/Clps	6.0	141	8.3	88		
Abla/Arco			4.6	187	1.5	200
Abla/Pial					5.0	174

[a] Coefficient of Variation = (SD)100/Mean.

[b] See Appendix Table 13 for key to vegetation type abbreviations.

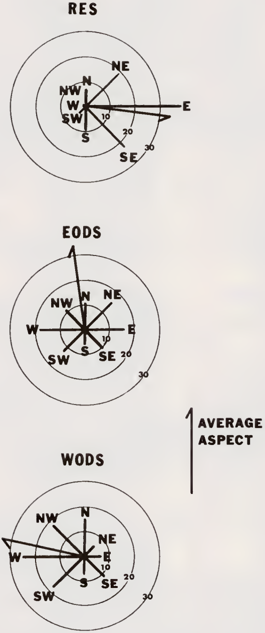

Figure 8. Mean percentages and average aspect found on 3 summer home range segments for mule deer on the East Front during 1979.

similar in average aspect. Proportions and means for the 4 slope categories in each segment are shown in Figure 9. As with aspect, the EODS and the WODS were the most similar in mean slope. Mean elevations for each segment were: RES = 1,832 m; EODS = 1,838 m; and WODS = 2,014 m.

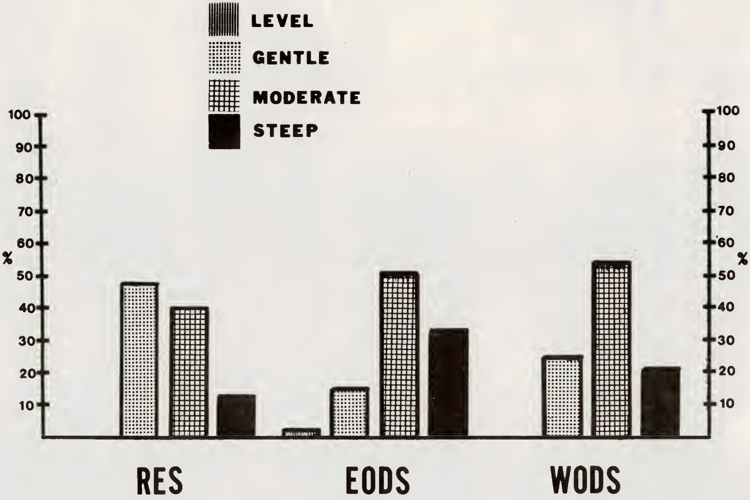

Figure 9. Mean percentages of 4 slope categories found on 3 summer home range segments for mule deer on the East Front during 1979.

DISCUSSION

Seasonal Distribution

Winter distribution of mule deer will vary from site to site and year to year in response to the severity of winter weather, but generalizations about "normal" distribution are necessary for management. Weather conditions during the winter of 1979-1980 were only slightly milder than the long term average. The winter of 1978-1979 was one of the most severe in several years. Temperatures were far below the average, and precipitation was above average for the period of November through February. A comparison of helicopter surveys flown in February and March of 1979 (McCarthy, Watts, Feist, Olson, and Bucsis 1979, unpubl. P-R Job Prog. Rep., Proj. W-130-R-10, Job I-4) with surveys flown during this study showed similar distributions for deer in all areas except the Blackleaf-Teton winter range. During 1979-1980, deer concentrations on the Blackleaf-Teton winter range did not extend to the Teton River as they did in 1978-1979.

Fidelity of radio-collared animals to individual winter ranges was high in this study. Fidelity has also been shown to be high in other mule deer populations in Montana by Pac (1976), Steerey (1979), Youmans (1979), Nyberg (1980), and Rosgaard (1981). Mean winter polygon home range size was larger than that reported by Steerey (1979), Youmans (1979), and Rosgaard (1981) for Bridger Mountain winter ranges. This larger mean winter home range size might be attributed in part to increased use of irrigated meadows and wet sites in late winter-early spring. Increased spring use of these sites has also been noted in other areas (Schwarzkoph 1973, Hamlin 1974, Nyberg 1980, Rosgaard 1981). Deer evidently responded to the greater abundance of green forage on these sites. Early green-up on these sites may be related to microclimate, soil fertility, or accelerated phenology displayed by some introduced plant species.

The timing of spring migration was similar in 1979 and 1980, and corresponded to the disappearance of snow in migration corridors. The South Fork of Deep Creek appeared to be the most heavily used migration corridor on the study area. Radio relocations indicated heavy use by the Castle Reef wintering population. The Long Ridge wintering population probably used this corridor to some extent also. Movement to summer ranges from winter ranges appeared to be direct and rapid.

Fidelity of females to summer home ranges was high. Similar findings have been reported for migratory deer elsewhere (Pac 1976, Rosgaard 1981). The significant decrease in mean summer home range size between 1979 and 1980 may reflect a response to the markedly cooler and wetter conditions in 1980. Drier conditions during 1979 may have resulted in lowered forage production and caused deer to utilize a larger area to satisfy their needs. Rosgaard (1981) reported a similar decrease in summer home range size in the Bridger Mountains over the same 2 years. The mean polygon summer home range size for females during 1979 was much larger than reported by Pac (1976), Steerey (1979), Nyberg (1980), and Rosgaard (1981) for other mountain foothill habitats, while the mean for 1980 was similar.

Fall migration eastward across the Continental Divide for the WODS deer appeared to be keyed to late fall snowstorms. Fall migrations of deer that crossed a major divide also appeared to be linked to late fall snowstorms in the Bridger Mountains of southwest Montana (Steerey 1979, Nyberg 1980, Rosgaard 1981). Similar movement patterns for elk on the study area were reported by Picton (1960). The WODS deer moved to transitional ranges in the foothills above the winter range. Transitional ranges were located in areas occupied by deer in the RES during the summer. Movement of all animals onto winter ranges appeared to be related to increasing snow depths on summer and transitional ranges.

Population Dynamics

The age distribution of deer trapped in drive-nets suggested that 46% of the population was 3½- to 5½- years of age. Only 7% was over 5½-years of age. This age distribution contrasted strongly with that of mule deer from the Armstrong winter range on the west side of the Bridger Mountains where nearly 40% of the population was 7½- to 10+-years-old in 1979-1980 (Mackie et al. 1980b). However, it was somewhat similar to the age structure reported by Nyberg (1980) for deer on the Brackett Creek winter range on the east side of the Bridger Mountains during the winter of 1978-1979 (31% 3½- to 5½- years -old and 31% over 5½-years of age).

The poor representation of the 1½- and 2½-year age-classes may reflect low fawn survival during the severe winters of 1977-1978 and 1978-1979. Age-classes that experienced mild to average winters as fawns were well represented among trapped animals. The absence of deer 6½-years of age and older in the sample corresponds to the 2 deer, either-sex bag limits and late hunts on the study area prior to 1975. In 1975, a bag limit of one antlered mule deer was enacted. This change in regulations reduced the harvest approximately 75% from an average over 1,000 mule deer/year (1971-1973) to about 250 mule deer/year (1974-1977) on the study area (Schallenberger, McCarthy, Watts, Feist, Erickson, Bucsis, and Olson 1971-1978, unpubl. P-R Job. Prog. Reps., Proj. W-130-R-3, 4, 5, 6, 7, 8, 9, Job I-4). However, hunter harvest alone cannot explain poor representation of the older age classes in this sample. The winter of 1971-1972 was severe and fawn: adult ratios during the winters of 1971-1972 and 1972-1973 were lower than the long term average (Schallenberger, Watts, Feist, and Erickson 1972-1973, unpubl. P-R Job Prog. Reps., Proj. W-130-R-3, 4, Job I-4). Other seasonal weather factors affecting mule deer fawn survival on the study area were reported by Picton (1979). These factors also probably contributed to the poor representation of the older age classes.

Mackie et al. (1980a) discussed the efficiency of helicopter surveys in estimating mule deer populations in mountain foothill habitats under different weather conditions. Following his conclusions, counts made on the south half of the study area in 1978 and 1979 (Table 11) during severe winters could represent a greater proportion of the total population than the count made in March of 1980 (possibly 65-75% versus 62%). If counting conditions during 1978 and 1979 surveys were similar enough for direct comparisons between the 2 years, the increase of 376 animals in the actual count represented a population increase of approximately 15% on the south half of the study area. A sampling efficiency of 70%, applied to the 1979 count would produce an estimate of 5,046 animals for the entire study area. The comparison of this estimate with the March, 1980 estimate indicated a 12% increase in the population between those 2 years. This information strongly suggests that the population has been steadily increasing for the last 3 years.

Fawn:adult ratios for February were higher than those for January. Rosgaard (1981) observed the same trend in classifications of mule deer in the Bridger Mountains during 1980. This may be the result of differential migration to the winter range or sampling error. Fawn: adult ratios showed no significant differences among the 5 winter

Table 11. Numbers of mule deer counted during helicopter surveys in 2 MFWPD management units on the East Front during 1978-1980.

	Unit 441	Unit 442
February 1978[a]		1,740
February 1979[b]	1,529	2,003
March 1980	1,473	2,015

[a] McCarthy, Watts, Feist, Olson, and Bucsis 1978, unpubl. P-R Job Prog. Rep., Proj. W-130-R-9, Job I-4.

[b] McCarthy, Watts, Feist, Olson, and Bucsis 1979, unpubl. P-R Job Prog. Rep., Proj. W-130-R-10, Job I-4.

ranges indicating similar rates of fawn production and survival for all winter range units, at least under weather conditions existing in 1979-1980.

Winter range densities for the Castle Reef and Scoffin Butte winter ranges during 1980 exceeded densities reported by Mackie et al. (1978), Steerey (1979), Nyberg (1980), and Rosgaard (1981) for Bridger Mountain winter ranges. Based on 1979-1980 population estimates, densities on these areas may approach 80 to 90 deer/km^2 when animals are restricted to primary winter range in severe winters. Ear Mountain and Blackleaf-Teton winter ranges were low density ranges holding only an estimated 19 to 30 deer/km^2 during severe winters.

No large wintering concentrations of mule deer are known to occur on the Blackfoot Indian Reservation (G. Olson, pers. comm.). Most deer occupying summer ranges west of the Reservation probably winter in the vicinity of Scoffin Butte. Thus, Scoffin Butte, the winter range with the highest density on the study area, may winter mule deer from a relatively larger area of summer range than other winter ranges.

Summer range densities in this study were lower than those reported by Nyberg (1980) and Rosgaard (1981). Proportions of the total population utilizing each summer range segment (as estimated by the summer distribution of radio-collared animals) were quite similar to proportions of the total range available to each segment. However, radio-collars were not distributed on winter ranges in the same relative proportion as the total populations of deer utilizing each winter range. The disproportionate distribution of radio-collared deer could have biased estimates of deer using each summer range segment.

Characteristics of Winter Range Used by Deer

Wallmo et al. (1977) suggested that deer might not meet their nutritional requirements on winter range, and that winter severity and fat reserves are important factors influencing survival on winter range. Moen (1968) and Staines (1976) stressed the importance of thermal cover in energy conservation. On this basis, winter ranges with good thermal cover in the form of vegetation or topography might support more deer during severe winters than winter ranges with poor thermal cover. A comparison of winter ranges on the basis of proportions and distribution of vegetation cover-types and topographic features could not explain differing deer densities among winter ranges. The only habitat variable measured that showed a strong correlation to deer density was mean elevation of the winter range. The relationship indicated increasing deer density with decreasing elevation.

Characteristics of Summer Range Used by Deer

Mackie (1978) discussed habitat diversity relative to natural population regulation and carrying capacity. He suggested that deer density increases with complexity, diversity, and stability of habitat. The areas of deer use in the EODS showed greater diversity in the kinds, amounts, and distribution of vegetation habitat types than other segments. The amount and distribution of aspect, slope, and elevational categories also showed greater diversity in the EODS than in other segments. Mean summer polygon home range size for the EODS was the smallest of the 3 segments in 1979 and 1980. Differences between the RES and WODS were less pronounced. The RES was more diverse than the WODS in distribution of vegetation habitat types and slope, but less diverse in distribution of aspect and elevation. Mean summer polygon home range size for the WODS was smaller than for the RES during 1980, but the sample size for the RES consisted of only 2 animals.

CONCLUSIONS

Mule deer exhibited a high degree of fidelity to seasonal home ranges on the study area. On this basis, there appear to be 6 essentially independent mule deer population units which can be designated by winter range origin. No strong relationships between deer density on seasonal ranges and vegetation type, aspect, or slope were evident. Deer density on winter range was negatively correlated with mean elevation. This suggested that deer selected winter ranges at the lowest available elevations that provided sufficient escape and thermal cover. The apparent growth of the population on the study area was not prevented by existing levels of domestic livestock grazing, winter weather conditions, hunting, predation, or human residential density during 1979-1980. Survival and productivity did not vary among the 5 intensively sampled population units during 1979-1980, and the total population increased by 10-15% per year from 1978 through 1980.

MANAGEMENT IMPLICATIONS

Harvest

Although a different harvest strategy could be applied to each of the winter range population units identified in this study, enforcement of regulations for each unit would be difficult. A more important concern is the management of deer harvest in specific summer range segments within population units. Under current regulations, deer in the WODS are harvested during early season hunts (mid-September through late October) on summer home ranges and during the regular season (late October through November) on transitional ranges. Deer from both the RES and WODS are concentrated on easily accessible transitional ranges during the regular season, but recovery of the WODS from excessive harvest might require more time than recovery in other segments because of the greater distances between summer and winter ranges associated with the WODS.

Oil and Gas Development

Total and primary winter ranges for mule deer on the study area were compared by subsurface ownership (Table 12). Less than 40% of the subsurface of Scoffin Butte, Dupuyer Creek, and Blackleaf-Teton primary winter ranges were held by the public, while Castle Reef primary winter range was almost 75% public subsurface. Almost all of the transitional and summer range delineated during this study was administered by the Federal government. Opportunities for management

Table 12. Percentage of subsurface ownership for 6 winter ranges on the East Front during 1979-1980.

Location	Total Winter Range Federal	Total Winter Range State	Total Winter Range Private	Primary Winter Range Federal	Primary Winter Range State	Primary Winter Range Private
Scoffin Butte	9	0	91	12	0	88
Dupuyer Creek	5	6	89	1	0	99
Blackleaf-Teton	54	6	40	30	8	62
Ear Mountain	44	19	37	56	10	34
Long Ridge	39	20	41	43	17	40
Castle Reef	83	12	5	63	11	26

are greater on areas with substantial portions of the subsurface under public control.

The mosaic of public and private ownership should be considered in management decisions. The ownership pattern on the study area should be used to plan a sequence of development to provide a refuge from development. Management in relation to surface ownership should be treated in a similar manner.

Oil and gas development during the period of study was limited to 2 weeks of seismic exploration and the first 4 weeks of drilling at a gas well on the Blackleaf Game Range. Although the potential impacts of oil and gas development on mule deer could not be evaluated on the basis of this limited activity, potential conflicts might be minimized through timing restrictions such as regulating access and activity on: 1) primary winter range from December 15 to May 15;

2) migration corridors from May 15 to June 15; and 3) transitional range from October 15 to December 31. Road location, construction, and use in previously unroaded areas could lead to increased legal harvest, illegal harvest, and harassment. These impacts could necessitate restrictions on location and use of new roads (Ward 1980).

Oil and gas development must also be examined in terms of combined impacts of all land-use activities. Changes in the extent of domestic livestock grazing, housing developments, recreation, and winter severity in combination with oil and gas development could produce significant changes in mule deer populations.

The population units delineated in this study provide an excellent opportunity to test the effects of different management strategies because these units were independent and yet similar in productivity and survival. Through continued monitoring, future impacts of oil and gas development could be compared against baseline data collected by MFWPD personnel and this study. Populations associated with individual winter ranges could be utilized as experimental (oil and gas development) and undisturbed control (no oil and gas development) units. Unless mule deer population trends and human land-use patterns on winter and summer ranges are monitored, future changes in populations due to oil and gas development could not be isolated from changes due to other factors.

APPENDIX

Appendix Table 13. Average temperature (°C), total precipitation (cm), snowfall (cm), and deviation from the long term average for 2 weather stations along the East Front from November 1978 through September 1980 (U. S. Dept. of Commerce 1978-1980).

		Temperature (°C)		Precipitation (cm)		
Month	Station[a]	Mean	Deviation (°C) from the long term average	Amount	Deviation (cm) from the long term average	Snowfall (cm)
Nov. 1978	GD	-3.4	-4.1	4.50	+1.45	22.5[b]
	BL					
Dec. 1978	GD	-8.1	-17.1	3.00	+.64	54.6
	BL	-9.6	-17.1	2.49	+1.09	
Jan. 1979	GD	-12.9	-7.4	1.80	-.66	39.6
	BL	-14.3	-7.2	2.90	+1.40	
Feb. 1979	GD	-6.0	-3.1	2.49	+.61	25.9
	BL	-8.8	-4.9	.71	-.81	
Mar. 1979	GD	.8	+2.4	2.84	+.23	20.3
	BL	.7	+2.6	1.45	-.23	
Apr. 1979	GD	3.7	-.4	3.73	-.15	24.1
	BL	2.7	-1.1	2.49	-1.14	
May 1979	GD	9.1	+.4	2.36	-5.79	0
	BL	9.3	+.3	1.50	-4.77	
June 1979	GD	14.1	+1.9	2.74	-7.82	0
	BL	15.3	+1.6	4.29	-2.57	
July 1979	GD	16.9	+.3	2.24	-1.24	0
	BL	17.8	+.8	1.02	-2.66	
Aug. 1979	GD	17.0	+1.1	3.25	-.38	0
	BL	18.2	+.6	.91	-2.90	
Sep. 1979	GD	14.6	+3.2	.69	-3.23	0
	BL	14.8	+3.5	.86	-1.96	

Appendix Table 13. Continued.

		Temperature (°C)		Precipitation (cm)		
Month	Station[a]	Mean	Deviation (°C) from the long term average	Amount	Deviation (cm) from the long term average	Snowfall (cm)
Oct. 1979	GD	8.9	+1.8	1.19	-1.78	0
	BL	8.3	+1.8	1.14	-.03	
Nov. 1979	GD	-.5	-1.2	.33	-2.72	3.05
	BL	-.2	+.2	.51	-1.12	
Dec. 1979	GD	.4	+3.2	3.45	+1.09	30.5
	BL	-.1	+4.2	2.26	+.86	
Jan. 1980	GD	-9.0	-3.5	3.23	+.76	42.7
	BL	-10.6	-3.3	2.46	+.91	
Feb. 1980	GD	-1.6	+1.4	2.08	+.20	45.7
	BL	-2.9	+1.2	2.08	+.56	
Mar. 1980	GD	-1.1	+.5	1.17	-1.45	13.2
	BL	-2.5	-.7	2.21	+.53	
Apr. 1980	GD	7.5	+3.4	5.84	+1.96	35.6
	BL	7.2	+3.5	5.33	+1.75	
May 1980	GD	10.6	+2.0	15.47	+7.32	0
	BL	11.3	+2.2	10.26	+1.65	
June 1980	GD	12.5	+.3	13.13	+2.57	0
	BL					
July 1980	GD	16.8	+.3	1.70	-1.78	0
	BL	18.2	+1.2	.61	-2.97	
Aug. 1980	GD	13.9	-2.1	2.62	-1.02	0
	BL	13.9	-2.3	3.58	-.13	
Sep. 1980	GD	12.6	+1.2	3.48	-.43	0
	BL	11.7	+.3	2.84	+.10	

[a] GD = Gibson Dam, BL = Blackleaf.

[b] Snowfall not recorded at this station.

Appendix Table 14. Mean percent frequency of occurrence and canopy coverage of lower stratum plant species in 12 cover-types for 5 winter ranges on the study area. Numbers of frames sampled are in parentheses.

Taxa	Irrigated Meadow (80)	Fesc-Agsp[a] (390)	Artr-Fesc (40)	Pofr-Fesc (140)	Pofr-Phpr (100)	Pifl-Fesc 1 (130)
Grasses and Grasslikes:						
Agropyron caninum				1/tr		
Agropyron dasystachyum		28/1	5/tr	4/tr	25/1	9/tr
Agropyron spicatum	11/tr[b]	67/6	88/7	57/2	18/1	69/4
Bromus carinatus		1/tr		6/1	4/tr	
Bromus inermis	33/6			1/tr	6/tr	
Bromus tectorum		5/tr	18/tr	1/tr	3/tr	2/tr
Calamagrostis sp.		1/tr		4/tr		
Carex filifolia		44/2	23/tr	33/2	21/1	33/1
Carex nebraskensis	26/1					
Carex stenophylla		2/tr		21/1	3/tr	
Carex xerantica	51/6				15/1	
Carex sp.	25/4	5/tr		1/tr	3/tr	
Danthonia intermedia		12/1	8/tr	19/2	13/1	
Danthonia unispicata		5/tr		6/tr		9/tr
Deschampsia elongata	36/2					
Festuca idahoensis		52/4	68/5	73/6	32/3	39/2
Festuca ovina		1/tr				
Festuca scabrella		77/6	75/4	76/8	51/4	70/5
Helictotrichon hookeri		1/tr		1/tr		
Juncus longistylis	76/8	2/tr			17/1	1/tr
Koeleria cristata		71/3	13/tr	28/1	17/tr	45/1
Muhlenbergia cuspidata		8/1			4/tr	
Phleum pratense	74/20			7/tr	65/10	
Poa pratensis	100/26	2/tr		9/1	69/9	3/tr
Poa sandbergii				1/tr		
Poa sp.		1/tr				
Stipa comata		1/tr				
Stipa occidentalis		11/1		18/1	22/1	
Stipa viridula		3/tr		16/1	4/tr	
Forbs:						
Achillea millefolium	20/1	12/tr	25/1	59/3	67/3	10/tr
Agoseris glauca	1/tr	3/tr		14/tr	7/tr	2/tr
Allium textile	6/tr	10/tr	5/tr	6/tr	3/tr	11/tr
Alyssum alyssoides		12/1	38/1			6/tr
Anemone sp.		3/tr	10/tr	31/3	21/2	5/tr
Antennaria microphylla	4/tr	21/1	20/tr	39/5	15/1	22/1

Appendix Table 14. Continued.

Taxa	Irrigated Meadow (80)	Fesc-Agsp[a] (390)	Artr-Fesc (40)	Pofr-Fesc (140)	Pofr-Phpr (100)	Pifl-Fesc 1 (130)
Apocynum medium						1/tr
Arenaria congesta		27/1	28/tr	42/1	1/tr	22/1
Artemisia campestris		1/tr				
Artemisia ludoviciana	4/tr	4/tr		5/tr	4/tr	
Astragalus adsurgens	4/tr	7/tr		15/1	2/tr	6/tr
Astragalus bisculatus		1/tr			8/1	6/1
Astragalus drummondii		7/tr		1/tr		4/tr
Astragalus gilviflorus		1/tr				
Astragalus sp.				1/tr		
Balsamorhiza incana		2/tr		1/tr	1/tr	
Balsamorhiza sagittata		13/2	63/11	3/tr		3/tr
Besseya wyomingensis		1/tr		9/tr	3/tr	
Bupleurum americanum		2/tr	3/tr	8/tr	4/tr	6/tr
Campanula rotundifolia		1/tr		8/tr	3/tr	
Castilleja lutescens		2/tr		5/tr		5/tr
Cerastium arvense		44/1		28/1	20/1	16/tr
Chrysopsis villosa	4/tr	27/1	8/tr	9/tr	28/1	14/tr
Cirsium vulgare		tr/tr		1/tr		
Clematis hirsutissima				2/tr	1/tr	
Collinsia parviflora			25/tr			1/tr
Collomia linearis	1/tr		5/tr		2/tr	5/tr
Comandra umbellata		21/1	15/tr	16/1	4/tr	14/tr
Crepis acuminata		2/tr	8/tr	1/tr		1/tr
Cryptantha interrupta		1/tr				1/tr
Descurainia pinnata		tr/tr				1/tr
Dodecatheon sp.				1/tr		
Douglasia montana				6/tr		10/tr
Draba reptans		1/tr				
Equisetum sp.	3/tr					
Erigeron caespitosus			15/tr	1/tr	1/tr	14/1
Erigeron ochroleucus		3/tr		13/1	11/1	
Erigeron speciosus		4/tr		3/tr	12/tr	
Eriogonum flavum		4/tr		2/tr		2/tr
Eritrichium howardii		tr/tr				
Fragaria virginiana				22/2	30/3	
Frasera speciosa		tr/tr				
Gaillardia aristata		4/tr		4/tr	2/tr	
Gallium boreale	10/1	32/2	40/1	75/5	80/7	28/1
Gaura coccinea		tr/tr				

Appendix Table 14. Continued.

Taxa	Irrigated Meadow (80)	Fesc-Agsp[a] (390)	Artr-Fesc (40)	Pofr-Fesc (140)	Pofr-Phpr (100)	Pifl-Fesc 1 (130)
Geranium viscosissimum	4/tr	1/tr	3/tr	11/1	19/2	
Geum macrophyllum	1/tr					
Geum triflorum		2/tr		15/1	11/1	
Hedysarum sulphurescens		4/tr		9/1	2/tr	2/tr
Heuchera cylindrica		2/tr		3/tr	1/tr	3/tr
Hymenoxys acaulis		20/1		1/tr		24/1
Iris missouriensis	24/2	3/tr	3/tr	4/tr	4/tr	1/tr
Liatris punctata		6/tr				3/tr
Linum perenne		2/tr		2/tr	1/tr	2/tr
Lithospermum ruderale		2/tr	3/tr	10/1	2/tr	1/tr
Lomatium macrocarpum		6/tr	20/1	9/tr	1/tr	12/tr
Lupinus sericeus		24/3	30/2	41/5	6/1	10/tr
Melilotus officinalis						2/tr
Monarda fistulosa		tr/tr		6/1	12/1	
Musineon divaricatum		2/tr	8/tr	1/tr		4/tr
Opuntia polyacantha		tr/tr				
Orthocarpus luteus		3/tr			1/tr	
Oxytropis sericea		10/1		6/tr	5/tr	2/tr
Oxytropis splendens		15/1		6/tr	5/tr	
Oxytropis viscida		4/tr				
Paronychia sessiliflora						5/tr
Pedicularis sp.				3/tr		
Penstemon confertus		2/tr		11/1	1/tr	
Penstemon eriantherus			3/tr			
Perideridia gairdneri						1/tr
Petalostemon candidum		2/tr				
Petalostemon purpureum		3/tr		1/tr		
Phacelia linearis		3/tr	3/tr			
Phlox alyssifolia		29/1	53/1	9/1	1/tr	40/1
Phlox hoodii		38/3		18/2	4/tr	25/1
Potentilla gracilis	34/4			4/tr	21/3	
Potentilla hippiana	1/tr	5/tr	3/tr	2/tr	11/1	4/tr
Sedum lanceolatum		1/tr		4/tr		10/tr
Senecio canus		9/tr	3/tr			10/tr
Senecio sp.	28/2				11/tr	
Smilacina racemosa					5/tr	
Solidago missouriensis				7/tr		
Taraxacum officinale	39/3	4/tr		9/tr	18/2	2/tr
Thelesperma subnudum		1/tr				
Thermopsis rhombifolia	4/tr	15/1	25/2	6/1	8/1	4/tr

Appendix Table 14. Continued.

Taxa	Irrigated Meadow (80)	Fesc-Agsp[a] (390)	Artr-Fesc (40)	Pofr-Fesc (140)	Pofr-Phpr (100)	Pifl-Fesc 1 (130)
Tragopogon dubius		2/tr				
Trifolium pratense	6/tr				14/tr	
Trifolium repens	63/10			1/tr	9/tr	
Triglochin maritumum	5/tr					
Vicia americana	15/tr	15/1	15/tr	6/tr	27/1	9/tr
Viola sp.		1/tr				
Zigadenus elegans		3/tr				
Zigadenus venosus		7/tr	23/2	16/1	7/tr	14/tr
Unidentified forb	13/tr	9/tr	12/tr	34/2	12/1	25/1
Half Shrubs:						
Artemisia frigida		48/5	5/tr	3/tr	6/tr	32/3
Gutierrezia sarothrae		7/tr				2/tr
Shrubs and Trees:						
Amelanchier alnifolia			8/tr	11/2		
Arctostaphylos uva-ursi		1/tr		4/1		2/1
Artemisia tridentata			35/4			
Juniperus horizontalis		21/8	10/6	6/2	6/1	50/22
Pinus flexilis						2/tr
Potentilla fruticosa	5/1	7/1		29/5	31/6	7/tr
Prunus virginiana				4/1		
Rosa sp.	9/1	11/1		39/4	38/6	3/tr
Shepherdia canadensis		tr/tr				
Spirea betulifolia				3/tr		
Symphoricarpos occidentalis	8/1	7/1	20/1	19/2	18/2	1/tr
Total Grasses	100/73	100/28	100/23	100/27	100/38	97/16
Total Forbs	95/23	100/28	100/21	100/33	100/33	99/17
Total Shrubs	13/3	72/16	63/13	81/22	77/17	71/27
Selaginella densa		16/3	10/tr	14/2		36/6
Lichen		24/1	3/tr	6/tr	1/tr	20/1
Moss	3/tr	2/tr		6/tr	1/tr	1/tr
Litter	100/25	100/32	100/33	99/38	100/38	100/34
Rock		44/6	63/5	16/2	8/1	41/4
Bare ground	1/tr	75/9	70/13	46/4	37/3	67/13

Appendix Table 14. Continued.

Taxa	Pifl-Fesc 2 (200)	Pifl-Fesc 3 (20)	Pifl-Junip (40)	Pifl-Potr (10)	Psme-Spbe (20)	Pifl-Beoc (20)
Grasses and Grasslikes:						
Agropyron caninum				10/tr		
Agropyron dasystachyum	22/1	35/2	5/tr	10/tr		5/tr
Agropyron spicatum	62/5	10/tr	38/1	10/tr	65/3	
Bromus carinatus	1/tr	25/2				
Bromus inermis	1/tr					
Calamagrostis rubescens					10/tr	
Carex filifolia	27/1	15/1	30/1			
Carex sp.	5/tr	5/tr	3/tr			65/5
Danthonia intermedia	10/tr					10/tr
Festuca idahoensis	32/3		25/1		5/1	
Festuca scabrella	67/5	35/4	25/1	20/1	25/1	45/2
Juncus longistylis				10/tr		70/5
Koeleria cristata	30/1		23/1		5/tr	
Muhlenbergia cuspidata						40/2
Phleum pratense	6/tr	10/tr				
Poa pratensis	11/2	20/3				
Poa sandbergii	2/tr		3/tr			
Stipa occidentalis	5/tr	25/1				
Stipa viridula	3/tr	15/2				
Forbs:						
Achillea millefolium	36/2	25/1	38/1		45/4	
Agoseris glauca	9/tr	10/1		20/1	15/tr	
Allium textile	3/tr					5/tr
Alyssum alyssoides	2/tr					
Anemone sp.	16/1	25/2	33/2	30/2	50/3	20/1
Antennaria microphylla	18/1	5/tr	28/1		5/1	5/tr
Arenaria congesta	19/tr		5/tr		25/1	
Arnica cordifolia					5/1	
Astragalus adsurgens	12/1	10/1	23/2		15/2	
Astragalus bisculatus	1/tr					
Astragalus sp.		15/2				
Balsamorhiza incana	1/tr					
Balsamorhiza sagittata	12/2	10/5			55/3	
Besseya wyomingensis	1/tr					
Bupleurum americanum	6/tr		10/1	20/1		

Appendix Table 14. Continued.

Taxa	Pifl-Fesc 2 (200)	Pifl-Fesc 3 (20)	Pifl-Junip (40)	Pifl-Potr (10)	Psme-Spbe (20)	Pifl-Beoc (20)
Campanula rotundifolia	1/tr		8/tr			15/tr
Castilleja lutescens	3/tr					
Cerastium arvense	34/1	5/tr	45/1		5/1	
Chrysopsis villosa	14/1	15/1	3/tr			
Clematis pseudoalpina	1/tr	15/5				
Collinsia parviflora	2/tr					
Collomia linearis	2/tr					
Comandra umbellata	12/tr				5/tr	15/tr
Crepis acuminata	2/tr					
Cryptantha interrupta	2/tr					
Descurainia pinnata	1/tr					
Douglasia montana	1/tr		10/1			
Draba reptans	2/tr					
Erigeron caespitosus	14/1	20/2	10/tr		15/tr	
Erigeron ochroleucus			5/tr			
Erigeron speciosus						60/3
Eritrichium howardii	1/tr					
Fragaria virginiana	10/tr			50/5	15/tr	10/1
Gaillardia aristata	4/tr		5/tr			
Gallium boreale	48/2	50/3	23/1	60/3	35/1	85/4
Geranium viscosissimum	1/tr					
Geum triflorum	1/tr					
Hedysarum sulphurescens	8/tr	10/tr			15/2	10/1
Hymenoxys acaulis	8/tr		8/tr			
Liatris punctata	2/tr					
Lesquerella sp.	1/tr					
Lilium philadelphicum						15/tr
Linum perenne	4/tr					
Lithospermum ruderale	4/tr	30/3			10/2	
Lomatium macrocarpum	12/tr		5/tr			
Lupinus sericeus	14/2	35/3				
Monarda fistulosa	1/tr			30/2		5/tr
Musineon divaricatum			3/tr			
Orthocarpus luteus	1/tr					
Oxytropis sericea	6/tr					
Oxytropis splendens	3/tr					
Penstemon confertus	6/tr	5/1	5/1			
Phlox alyssifolia	17/1		13/tr		10/tr	15/2

Appendix Table 14. Continued.

Taxa	Pifl-Fesc 2 (200)	Pifl-Fesc 3 (20)	Pifl-Junip (40)	Pifl-Potr (10)	Psme-Spbe (20)	Pifl-Beoc (20)
Phlox hoodii	16/1					
Potentilla hippiana	3/tr					
Sedum lanceolatum	4/tr		18/tr		5/tr	
Senecio canus	1/tr	5/tr	15/tr			
Senecio sp.						5/tr
Smilacina racemosa	1/tr	10/tr		10/2		10/tr
Solidago missouriensis						5/tr
Taraxacum officinale	16/1	20/1	20/2	10/2		
Thalictrum occidentale						5/1
Thermopsis rhombifolia	20/2					
Tragopogon dubius	1/tr					
Trifolium pratense	1/tr					
Trifolium repens	2/tr					
Vicia americana	15/1	35/2		20/tr	5/1	5/tr
Zigadenus elegans	3/tr	5/tr	25/1	30/3		10/tr
Zigadenus venosus	12/tr					
Unidentified forb	16/1		25/1	10/tr	40/1	30/1
Half Shrubs:						
Artemisia frigida	12/tr					
Shrubs and Trees:						
Amelanchier alnifolia	1/tr					
Arctostaphylos uva-ursi	29/12	35/12	33/6	80/27	10/1	60/20
Berberis repens				10/2		
Juniperus communis			5/2			
Juniperus horizontalis	36/13	40/6	45/15	40/18	45/17	65/21
Pinus flexilis	1/tr			10/tr		
Potentilla fruticosa	12/2	10/1	38/6	50/4	10/2	35/5
Prunus virginiana	1/tr					
Pseudotsuga menziesii			3/tr	10/tr	5/1	
Rosa sp.	19/2	10/1	5/tr	40/5	40/2	15/3
Shepherdia canadensis	1/tr				15/2	
Spirea betulifolia	1/tr				50/13	
Symphoricarpos occidentalis	12/1	45/9	5/tr	40/2	40/2	

Appendix Table 14. Continued.

Taxa	Pifl-Fesc 2 (200)	Pifl-Fesc 3 (20)	Pifl-Junip (40)	Pifl-Potr (10)	Psme-Spbe (20)	Pifl-Beoc (20)
Total Grasses	96/19	75/16	78/6	40/1	80/6	85/19
Total Forbs	99/24	95/27	93/15	100/17	80/24	95/21
Total Shrubs	82/31	85/28	85/33	100/55	90/36	85/48
Selaginella densa	9/1		5/tr			
Lichen	10/tr		15/1		10/tr	
Moss	4/tr		3/1	10/tr	40/w	
Litter	100/40	100/57	95/45	100/60	100/59	100/33
Rock	27/3	15/2	40/10	10/tr	5/tr	5/tr
Bare ground	49/5	30/2	43/6		20/tr	30/2

[a] See Appendix Table 18 for key to 4-letter plant species abbreviations.
[b] Mean percent frequency of occurrence/mean percent canopy coverage; tr = trace, a value less than 0.5%.

Appendix Table 15. Density (N/Ha) and canopy coverage (%) of mid-stratum vegetation within cover-types sampled on the East Front during 1980. Numbers of points sampled are in parentheses.

Taxa	Artr-Fesc[a] (40)	Pofr-Fesc (140)	Pofr-Phpr (100)	Pifl-Fesc 1 (130)	Pifl-Fesc 2 (200)
Amelanchier alnifolia	76/tr[b]	33/tr			7/tr
Artemisia fridida			141/tr		
Artemisia tridentata	3599/12			1/tr	
Eleagnus commutata					8/tr
Juniperus communis					6/tr
Juniperus scopulorum			tr/tr		9/tr
Pinus contorta					1/tr
Pinus flexilis	25/tr	146/1		50/1	108/1
Potentilla fruticosa	51/tr	3009/6	4620/5	22/tr	207/tr
Prunus virginiana		33/tr	31/tr	tr/tr	4/tr
Pseudotsuga menziesii		7/tr		1/tr	7/tr
Rhus trilobata	76/tr			tr/tr	2/tr
Ribes cereum		7/tr		36/tr	13/tr
Ribes inerme				tr/tr	2/tr
Rosa sp.	76/tr	280/tr	1206/tr	2/tr	96/tr
Salix sp.			16/tr		
Shepherdia canadensis		27/tr	16/tr	6/tr	94/1
Symphoricarpos occidentalis	152/tr	186/tr	251/tr	2/tr	27/tr

Appendix Table 15. Continued.

Taxa	Pifl-Fesc 3 (20)	Pifl-Junip (40)	Pifl-Beoc (20)	Pifl-Potr (10)	Psme-Spbe (20)
Amelanchier alnifolia	16/tr				47/tr
Betula occidentalis			3095/12		
Eleag~~h~~nus commutata				390/tr	
Pinus flexilis	371/2	901/10		781/13	47/tr
Populus tremuloides				586/tr	
Potentilla fruticosa	649/1	820/2	7400/12	1659/3	471/tr
Prunus virginiana				98/tr	
Pseudotsuga menziesii		48/tr			377/1
Ribes cereum		16/tr			
Rosa sp.	371/tr	64/tr		293/tr	424/tr
Salix sp.			269/tr		
Shepherdia canadensis	433/1	708/5			1977/10
Spirea betulifolia					94/tr
Symphoricarpos occidentalis	649/tr			98/tr	380/tr

[a] See Appendix Table 18 for key to 4-letter plant species abbreviations.

[b] Mean numbers of plants per hectare/mean percent canopy coverage; tr = trace, a value less than 0.5%.

Appendix Table 16. Density (N/Ha) and canopy coverage (%) of upper stratum vegetation within cover-types sampled on the East Front during 1980. Number of points sampled are in parentheses.

Taxa	Pifl-Fesc1[a] (110)	Pifl-Fesc 2 (150)	Pifl-Fesc 3 (20)	Pifl-Junip (20)	Pifl-Beoc (20)	Pifl-Potr (10)	Psme-Spbe (20)
Betula occidentalis		1/tr			8/tr		
Picea engelmannii					1/tr		
Pinus contorta					1/tr		
Pinus flexilis	98/10[b]	337/24	1016/63	208/10	43/1	375/14	383/22
Populus tremuloides						250/3	
Pseudotsuga menziesii	2/tr[c]	19/2	13/2	15/1			518/27
Salix sp.					1/tr		

[a] See Appendix Table 18 for key to 4-letter plant species abbreviations.
[b] Mean numbers of plants per hectare/mean percent canopy coverage.
[c] Tr = trace, a value less than 0.5%.

Appendix Table 17. Descriptions of cover-types delineated but not quantitatively sampled.

Water

The surface of lakes or ponds on the study area.

Scree

Moderate to steep unstable slopes composed of talus or rock debris.

Aspen

Upper stratum - *Populus tremuloides*
Mid-stratum - *Populus tremuloides, Potentilla fruticosa, Prunus virginiana, Rosa* sp., *Salix* sp., *Symphoricarpos occidentalis*
Lower stratum - *Agropyron caninum, Carex* sp., *Deschampsia elongata, Geranium richardsonii, Geranium viscosissimum, Juncus longistylis, Monarda fistulosa, Phleum pratense, Potentilla gracilis, Taraxacum officinale, Thalictrum occidentale*

Riparian Shrub

Mid-stratum - *Betula occidentalis, Eleagnus commutata, Potentilla fruticosa, Rosa* spp., *Salix* spp., *Symphoricarpos occidentalis*
Lower stratum - *Carex* sp., *Juncus longistylis, Iris missouriensis, Monarda fistulosa, Phleum pratense, Potentilla gracilis, Taraxacum officinale, Thalictrum occidentale*

Riparian Tree

Upper stratum - *Populus trichocarpa*
Mid-stratum - *Betula occidentalis, Eleagnus commutata, Rosa* sp., *Salix* sp., *Symphoricarpos occidentalis*
Lower stratum - *Carex* sp., *Juncus longistylis, Fragaria virginiana, Geranium viscosissimum, Phleum pratense, Potentilla gracilis, Taraxacum officinale*

Swamp

Upper stratum - *Betula occidentalis, Populus tremuloides, Populus trichocarpa*
Mid-stratum - *Prunus virginiana, Rosa* sp., *Salix* sp.

Appendix Table 17. Continued.

Lower stratum - *Carex* sp., *Juncus longistylis, Deschampsia elongata, Equisetum arvense, Heracleum lanatum, Triglochin maritimum, Typha latifolia, Urtica dioica.* Lee and Jonkel (1981) describe this type.

Pico[a]

Upper stratum - *Pinus contorta*
Mid-stratum - *Berberis repens, Juniperus communis, Spirea betulifolia*
Lower stratum - *Arnica cordifolia, Calamagrostis rubescens, Carex geyeri, Clematis pseudoalpina, Vaccinium scoparium*

Snowdrift Shrub

Mid-stratum - *Acer glabrum, Amelanchier alnifolia, Prunus virginiana, Rosa* sp., *Symphoricarpos occidentalis*
Lower stratum - *Bromus carinatus, Carex* sp., *Geranium viscosissimum, Hackelia* sp., *Heracleum lanatum, Monarda fistulosa, Phleum pratense, Potentilla gracilis*

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[a] See Appendix Table 18 for key to 4-letter plant species abbreviations.

Appendix Table 18. Key to 4-letter plant species abbreviations.

Abla - *Abies lasiocarpa*
Agsp - *Agropyron spicatum*
Arco - *Arnica cordifolia*
Artr - *Artemisia tridentata*
Beoc - *Betula occidentalis*
Clps - *Clematis pseudoalpina*
Feid - *Festuca idahoensis*
Fesc - *Festuca scabrella*
Junip -*Juniperus* sp.
Libo - *Linnaea borealis*
Mefe - *Menziesia ferruginea*
Phpr - *Phleum pratense*
Pien - *Picea engelmannii*
Pial - *Pinus albicaulis*
Pico - *Pinus contorta*
Pifl - *Pinus flexilis*
Pofr - *Potentilla fruticosa*
Psme - *Pseudotsuga menziesii*
Smst - *Smilacina stellata*
Spbe - *Spirea betulifolia*
Xete - *Xerophyllum tenax*

LITERATURE CITED

Aune, K. 1981. Rocky Mountain Front grizzly bear monitoring and investigation. Mont. Dept. Fish, Wildl. Parks, Helena. 50 pp.

Beasom, S. L., W. Evans, and L. Temple. 1980. The drive net for capturing western big game. J. Wildl. Manage. 44(2):478-480.

Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecol. 37:451-460.

Daubenmire, R. F. 1959. A canopy coverage method of vegetational analysis. N. W. Sci. 33(1):43-64.

Deiss, C. F. 1943. Structure of the central part of the Sawtooth Range, Montana. Bull. Geol. Soc. 54(3):1123-1168.

Erickson, G. L. 1972. The ecology of Rocky Mountain bighorn sheep in the Sun River area of Montana with special reference to summer food habits and range movements. M.S. Thesis. Mont. State Univ., Bozeman. 50 pp.

Frisina, M. R. 1974. Ecology of bighorn sheep in the Sun River area of Montana during fall and spring. M.S. Thesis. Mont. Univ., Bozeman. 68 pp.

Hamlin, K. L. 1974. Ecological relationships of mule deer in the Bridger Mountains, Montana, with special reference to daily and seasonal movements. M.S. Thesis. Mont. State Univ., Bozeman. 65 pp.

Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. U. Wash. Press, Seattle. 730 pp.

Johns, W. M. 1970. Geology and mineral deposits of Lincoln and Flathead Counties, Montana. Bull. 79, Montana Bureau Mines. 182 pp.

Knight, R. R. 1970. The Sun River elk herd. Wildl. Monogr. No. 23. 66 pp.

Lee, L. and C. J. Jonkel. 1981. Vegetation structure and ecology of grizzly bear habitat in the Pine and Antelope Butte wetlands. Border Grizzly Project Spec. Rep. No. 36. Univ. of Montana, Missoula. 65 pp.

Lightfoot, W. C. and V. Maw. 1963. Trapping and marking mule deer. Proc. Western Assoc. Game and Fish Comm. 43:138-142.

Mackie, R. J. 1978. Natural regulation of mule deer populations. *In*: D. S. Eastman and F. L. Bunnell (Editors). Natural Regulation of Wildlife: Proc. of a Symp. Academic Press, Inc., N.Y. (in press).

_________, D. F. Pac, and H. E. Jorgensen. 1978. Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana. *In*: Montana Deer Studies. Job Prog. Rep., Fed. Aid Proj. W-120-R-9. pp. 81-128.

_________, K. L. Hamlin, and D. F. Pac. 1980a. Census methods for mule deer. 1980 Northwest Section TWS Symposium on Census and Inventory Methods for Populations and Habitats, Banff, Alberta. (in press).

_________, D. F. Pac, and H. E. Jorgensen. 1980b. Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana. *In*: Montana Deer Studies. Job Prog. Rep., Fed. Aid Proj. W-120-R-11. pp. 96-141.

Marcum, L. C. and D. O. Loftsgaarden. 1980. A non-mapping technique for studying habitat preferences. J. Wildl. Manage. 44(4):963-968.

Mimmack, G. M., P. D. Morant, T. M. Crowe, and A. McKenzie. 1980. Biological applications of a computer programme package (DIRECT) for statistical analysis of two-dimensional directional data. S. Afr. J. Wildl. Res. 10:29-37.

Moen, A. N. 1968. The critical thermal environment: a new look at an old concept. Bioscience 18(11):1041-1043.

Montana Oil Journal. May 14, 1981. Vol. 61. No. 14.

Mudge, M. R., D. D. Rice, R. L. Earhart, and G. E. Claypool. 1978. Mineral resources of the Bob Marshall Wilderness and adjacent study areas, Lewis and Clark, Teton, Pondera, Flathead, Lake, Missoula, and Powell counties, Montana. U.S. Geol. Surv., Open-file rep. 78-295. 187 pp.

Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA For. Ser. Gen. Tech. Rep. INT-66, Intermountain Forest and Range Experiment Station. Ogden, Utah. 154 pp.

Nie, N. H., C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Bent. 1975. Statistical package for the social sciences. 2nd Edition. McGraw-Hill, Inc., New York. 675 pp.

Nyberg, H. E. 1980. Distribution, movements and habitat use of mule deer associated with the Brackett Creek winter range, Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 106 pp.

Overton, W. S. and D. E. Davis. 1969. Estimating the numbers of animals in wildlife populations. *In*: R. H. Giles (Editor) Wildlife Management Techniques. 3rd Edition. Printed for the Wildlife Society by Edwards Brothers, Inc., Ann Arbor, Michigan. 623 pp.

Pac, D. F. 1976. Distribution, movements, and habitat use during spring, summer, and fall by mule deer associated with the Armstrong winter range, Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 120 pp.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. USDA For. Ser. Gen. Tech. Rep. INT-34, Intermountain Forest and Range Experiment Station. Ogden, Utah. 174 pp.

Picton, H. D. 1960. Migration patterns of the Sun River elk herd, Montana. J. Wildl. Manage. 24(3):279-290.

__________ and I. E. Picton. 1975. Saga of the Sun. Montana Dept. of Fish, Wildlife, and Parks. Helena, Montana. 55 pp.

__________. 1979. A climate index and mule deer fawn survival in Montana. Int. J. Biometeor. 23(2):115-122.

Robinette, W. L., D. A. Jones, G. Rogers, and J. S. Gashwiler. 1957. Notes of tooth development and wear for Rocky Mountain mule deer. J. Wildl. Manage. 21(2):134-153.

Rosgaard, A. I. 1981. Ecology of mule deer associated with the Brackett Creek winter range, Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 76 pp.

Schallenberger, A. D. 1966. Food habits, range use and interspecific relationships of bighorn sheep in the Sun River area, west-central Montana. M. S. Thesis. Mont. State Univ., Bozeman. 44 pp.

________________ and C. J. Jonkel. 1978. Rocky Mountain East Front studies, 1977. Border Grizzly Project Spec. Rep. No. 18. Univ. of Montana, Missoula. 69 pp.

________________ and __________________. 1979. Rocky Mountain East Front grizzly studies, 1978. Border Grizzly Project Spec. Rep. No. 27. Univ. of Montana, Missoula. 115 pp.

________________ and __________________. 1980. Rocky Mountain East Front grizzly studies, 1979. Border Grizzly Project Spec. Rep. No. 39. Univ. of Montana, Missoula. 207 pp.

Schwarzkoph, W. F. 1973. Range use and relations of mule deer on the west slope of the Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 65 pp.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods. 6th Edition. Iowa State Univ. Press, Ames. 593 pp.

Staines, B. W. 1976. The use of natural shelter by red deer (*Cervus elaphus*) in relation to weather in north-east Scotland. J. Zool. (Lond.) 180:1-8.

Steerey, W. F. 1979. Distribution, range use and population characteristics of mule deer associated with the Schafer Creek winter range, Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 119 pp.

Thompson, M. J. 1981. Mountain goat distribution, population characteristics and habitat use in the Sawtooth Range, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 80 pp.

U. S. Dept. of Agriculture, Soil Conservation Service. 1980. Snow survey measurements for Montana. Ann. Summary.

U. S. Dept. of Commerce. 1978-1980. Climatological data for Montana. National Oceanic and Atmospheric Administration. Environmental Data Service. Asheville, N. C. Vols. 81-83.

Wallmo, O. C., L. H. Carpenter, W. L. Regelin, R. B. Gill, and D. L. Baker. 1977. Evaluation of deer habitat on a nutritional basis. J. Range Manage. 30(2):122-127.

Ward, A. L. 1980. Multiple use of timbered areas: Views of a wildlife manager specifically for elk and mule deer. pp. 1-24. *In* Meeting the challenge of the 80's - Proceeding: Rocky Mountain Forest Industries Conference. Jackson, Wyo. 170 pp.

Youmans, H. B. 1979. Habitat use by mule deer of the Armstrong winter range, Bridger Mountains, Montana. M. S. Thesis. Mont. State Univ., Bozeman. 66 pp.